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SAFETY MANAGEMENT OF TRANS JAVA TOLL ROAD WITH *VISION ZERO* APPROACH (NGAWI - KERTOSONO TOLL ROAD *SEGMENT*)

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ABSTRACT

The Ngawi-Kertosono Toll Road, essential for supporting Indonesia's mobility and economy, faces significant traffic safety challenges, evidenced by high accident rates attributed to excessive speed, poor road conditions, and human error. This study identifies critical black spots through accident data analysis and proposes the Vision Zero approach as an effective strategy to eliminate road fatalities. Key recommendations include improving infrastructure, such as clearer traffic signage and geometric road enhancements in accident-prone areas, as well as driver education through defensive driving training and awareness campaigns about risks at dangerous points. Strengthening law enforcement against traffic violations is crucial for creating a deterrent effect, and implementing advanced traffic monitoring systems can help detect and prevent potential accidents in real time. By adopting these measures, it is anticipated that accident rates will decrease, thereby enhancing traffic safety on the Ngawi-Kertosono Toll Road and moving closer to the Vision Zero goal.

Keywords: accident analysys; driver education; infrastructure recovery; tol road ngawi-kertosono, traffic monitoring; traffic safety; vision zero

INTRODUCTION

The Ngawi-Kertosono toll road is an integral part of the Trans-Java Toll Road network that plays an important role in supporting mobility and the economy in Indonesia. With a length of approximately 87 kilometers, this section connects various strategic areas in Java and is the main route for private vehicles as well as freight transport. However, despite significant benefits in terms of time savings and convenience, the toll road faces serious traffic safety issues. The high number of accidents on these toll roads is generally triggered by a combination of factors such as high speed, sub-optimal road conditions, and human error, often resulting in fatal accidents or serious injuries. Lack of public awareness about the importance of safe driving also plays a major role in the high number of accidents. (Alzayani & Alsabbagh, 2022)In addition to the infrastructure that is not fully supportive, especially in accident-prone areas, there is a lack of public awareness about the importance of driving safety. (Gijre & Ram, 2023).. Focusing on the safety of vulnerable road users, such as pedestrians and motorcyclists, should be a major concern in efforts to address this issue. (Alzayani & Alsabbagh, 2022).. In addition, the use of surrogate safety indicators can help in analyzing the potential risks in a particular area (Gijre & Ram, 2022). (Gijre & Ram, 2023; Oktopianto & Pangesty, 2021).

The utilization of technologies such as *UAVs* for monitoring and data collection is also expected to provide more accurate information about traffic conditions (Badrloo et al., 2021). (Badrloo et al., 2022; Ballesteros et al., 2020; Chen et al., 2015; Ghazzai et al., 2019; Huang et al., 2018; Li et al., 2019; Renard et al., 2022; Vinet & Zhedanov, 2011; Wang et al., 2021; Zhang et al., 2020).. Coordination between stakeholders in handling safety in this toll road section is also considered not optimal, especially in handling accident-prone areas *(black spots*). (Guo et al., 2018; Oktopianto & Pangesty, 2021).. Analysis of road user behavior can provide additional insight into the factors that contribute to accidents (Namatovu et al., 2018; Oktopianto &

Pangesty, 2021). (Namatovu et al., 2022; Vinet & Zhedanov, 2011), in comparison, recommendations for infrastructure and regulatory interventions can be made. While recommendations for appropriate infrastructure and regulatory interventions can significantly improve safety (Vinet & Zhedanov, 2011). (Vinet & Zhedanov, 2011).. A multidisciplinary approach, including the involvement of different sectors, is essential to ensure the successful implementation of planned safety measures. Along with increasing attention to road safety, the *Vision Zero* approach has become a strategy considered effective in reducing fatal and serious injury crashes (Moran, 2022; Shangguan et al., 2024; Webber et al., 2024). *Vision Zero*, first implemented in Sweden, aims to eliminate road deaths and serious injuries through a combination of interventions such as infrastructure improvements, speed limit reductions, and driver education. (Vinet & Zhedanov, 2011; Webber et al., 2024).. The importance of safety education and campaigns must be emphasized, especially for vulnerable road users. (Charisma et al., 2019; Habib et al., 2024; Nakao et al., 2022; Namiri et al., 2023).. Given its successful implementation in several countries, this study aims to identify the potential for *Vision Zero* implementation on the Ngawi-Kertosono toll road, focusing on analyzing accidents at vulnerable points and providing recommendations in the form of geometric design improvements, installing more effective warning signs, and implementing early detection technology to reduce the risk of fatal accidents. Through this research, it is hoped that driving safety on the toll road can be improved, in line with efforts towards *vision zero*.

METHOD

This study focuses on the 87-kilometer Ngawi-Kertosono toll road section, chosen due to its high traffic volume and significant accident rate in recent years. Data collection is done by relying on sources from authorities, such as the police and toll road managers, which include accident data (2020-2023) consisting of the number of accidents, the types of vehicles involved, the time of the accident, and the factors causing the accident. Road infrastructure data will also be collected, including road conditions, geometry, presence of signs, and speed limits, to understand the contribution of infrastructure to crashes. Furthermore, traffic flow data, such as vehicle volumes and speeds, will be analyzed to identify the relationship between traffic density and crash rates.

The crash analysis methods to be used include *Equivalent Accident Number (EAN)* to measure crash severity, and *Upper Control Limit (UCL)* to identify crash *hotspots*. The study will also analyze crash patterns based on crash type, time of occurrence, and weather conditions, and evaluate the correlation between traffic density and crash rates. A literature review on *vision zero* best practices in developed countries such as Sweden and the Netherlands will serve as a reference in developing a safety improvement strategy for the Ngawi-Kertosono toll road. The *EAN (Error, Analyze and Negotiations)* and *UCL (Upper Control Limit)* methods of assessing traffic accident prone areas have been adopted by several researchers, including Bolla, M.E. and Pignataro (1973)**,** who introduced the concept of accident equivalents to calculate the impact of traffic accidents. Each type of accident is given a different weight based on its severity, which is then converted into accident costs, thus facilitating comparison and prioritization in handling accident-prone areas.
According to Soemitro (2005) in his research (Oktopianto & Pangesty, 2021) In calculating the equivalent number of traffic accidents, the standard weight values for various types of accidents include death (MD) = 12, serious injury (LB) = 6, light injury (LR) = 3, and vehicle damage (K) = 1. So that the calculation of the equivalent number of accidents in an area using the standard weight of Soemitro (2005), the formula used is:

$$EAN = 12\,MD + 6\,LB + 3\,LR + 1\,K$$

The accident rate per kilometer of road that has a weight value (EAN) exceeding a certain limit is used to determine accident-prone locations. The next step is to calculate the *mean of* the crash rate per kilometer and the *standard deviation* of the data:
The mean (μ) of crashes per kilometer was calculated using the formula:

$$\mu = \frac{\sum_{i=1}^{n} EAN_i}{n}$$

Where :

- EANi is the equivalent number on road segment i
- n is the number of road segments analyzed.

The standard deviation (σ) is calculated using the formula :

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(EAN_i - \mu)^2}{n-1}}$$

After calculating the mean and standard deviation, the *BKA* or *UCL* value can be calculated using the formula:

$$BKA = \mu + k \times \sigma$$

Where:

- μ is the average number of crash equivalents per kilometer,
- σ is the standard deviation of the crash data per kilometer,
- k is a coefficient that is usually set according to the severity. The value of k is usually 2 or 3, depending on how strict surveillance is desired (k = 3 means that locations where the crash rate is more than three standard deviations above the mean are considered highly crash-prone).

$$UCL = \lambda + \psi\sqrt{\left(\left[\left(\frac{\lambda}{m}\right) + \left(\frac{(0.829)}{m}\right) + \left(\frac{1/2}{m}\right)\right]\right)}$$

RESULT AND DISCUSSION

The analysis shows the identified *black spots* on the Ngawi-Kertosono Toll Road.

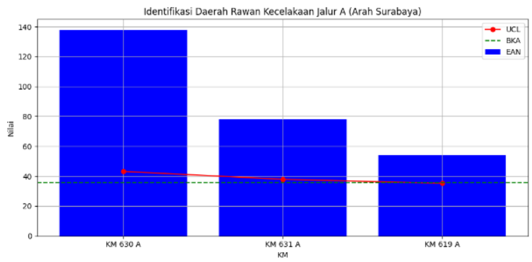

Figure 1. *Black Spot* Identification on Lane A (Surabaya Direction)

In Lane A (Surabaya Direction), KM 630 A shows the highest *Equivalent Accident Number* (*EAN*) of 138, which significantly exceeds the *Upper Control Limit* (*UCL*) of 43.17 and *Baseline Accident Rate* (*BKA*) of 35.74. This makes it one of the most dangerous *black spots* on the toll road. Furthermore, KM 631 A with an *EAN* of 78 and a *UCL* of 37.9 also shows high-risk potential, while KM 619 A has the lowest *EAN* on Line A, at 54, but is still slightly above the *UCL* of 35.24.

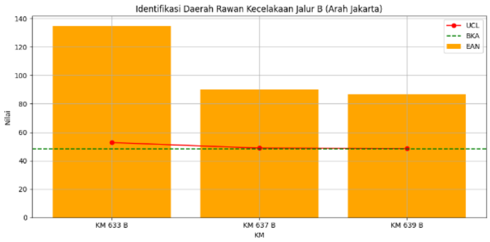

Figure 2. *Black Spot* Identification on Line B (Jakarta Direction)

On-Line B (Jakarta Direction), KM 633 B is the highest black spot with an *EAN* of 135, exceeding the *UCL of* 52.7 and BKA of 48.34, indicating the urgency of handling in this area. KM 637 B and KM 639 B with *EANs* of 90 and 87 respectively are also in the *black spots* that require attention. The results of this analysis highlight a clear pattern of accident-prone areas, especially at points with *EAN* values exceeding the *UCL* and BKA.

Data Collection and Identification of Accident Prone Areas

The implementation of this research identifies accident-prone areas on the Ngawi - Kertosono Toll Road, which is divided into Lane A (eastbound/Surabaya) and Lane B (westbound/Jakarta). From the analysis conducted, the analysis results for lane A and lane B, which get the highest ranking of DRK (Accident Prone Areas) are as follows:

Table 1
Identification of Accident Prone Areas of Ngawi - Kertosono Toll Road
Lane A (Surabaya direction)

Lane A (Surabaya direction)	KORBAN			EAN			EAN	UCL	BKA	Description EAN and UCL	Description EAN and BKA
	MD	LB	LR	12 * MD	6*LB	3*LR					
KM 630 A	1	11	20	12	66	60	138	43.17	35.74	*Black Spot*	*Black Spot*
KM 631 A	4	1	8	48	6	24	78	37.9	35.74	*Black Spot*	*Black Spot*
KM 619 A	1	6	2	12	36	6	54	35.24	35.74	*Black Spot*	*Black Spot*

Source: Analysis Results, 2024

Based on the table above, it is known that the BKA value is 35.74 with the highest value of *black spots* on lane A at KM 630 A with an *EAN* value of 138 and a *UCL* value of 43.17. Then the *black spot* at KM 631 A with an *EAN* value of 78 and a *UCL* value of 37.9 and the last *blackspot* is at KM 619 A with an *EAN* value of 54 and a *UCL* value of 35.24.

Table 2.
Identification of Accident Prone Areas on the Ngawi - Kertosono Toll Road Lane B (Jakarta direction)

Lane B (Jakarta direction)	KORBAN			EAN			EAN	UCL	BKA	Ket EAN and UCL	Ket EAN and BKA
	MD	LB	LR	12 * MD	6*LB	3*LR					
KM 633 B	4	6	17	48	36	51	135	52.7	48.34	*Black Spot*	*Black Spot*
KM 637 B	3	6	6	36	36	18	90	48.85	48.34	*Black Spot*	*Black Spot*
KM 639 B	2	6	9	24	36	27	87	48.56	48.34	*Black Spot*	*Black Spot*

Source: Analysis Results, 2024

Based on the table above, it can be seen that the BKA value is 48.34 with the highest value of *black spots* on lane B at KM 633 B with an *EAN* of 135 and a *UCL* value of 52.7. Then the *black spot* at KM 637 B with an *EAN* of 90 and a *UCL* of 48.85 and the last *blackspot* is at KM 639 B with an *EAN* of 87 and a *UCL* of 48.56.

Analysis of Accident Characteristics on the Ngawi - Kertosono Toll Road Section

Accident Characteristics at KM 630 A

From the results of the analysis that has been carried out by researchers, the results of the analysis of accident characteristics at KM 630 A are shown in the table and diagram as follows:

Table 3.
Analysis of Accident Characteristics at KM 630 A

Accident Location (KM)	Time	Vehicles Involved	Type Accident
630 + 600 A	5:20 p.m. Monday, 24/4/2023	Collision (> 1 vehicle)	Front, Rear, Side Collision
630 + 100 A	19.45 Friday, 29/9/2023	Single	Derailed
630 + 200 A	At 16.40 Monday, 5/15/2023	Continuous (> 1 vehicle)	Front, Rear, Side Collision

Source: Analysis Result, 2024

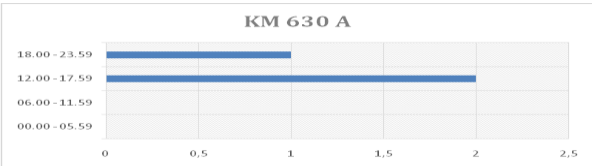

Figure 3. Analysis of Accident Occurrence Time at KM 630 A

The occurrence of accidents at the time of 12:00 - 17:59, which is the time from noon to evening. Further data in the period of 2020 - 2023, where there were 3 (three) accidents at KM 630 A, there were single accidents or successive accidents involving several vehicles.

Table 4
Analysis of Accident Characteristics at KM 630 A (Driver Factor)

Location	Drowsiness	Lack of Anticipation
KM 630 A	2	1

Source: Analysis Results, 2024

Accidents that occurred at KM 630 A in 2020 - 2023, occurred due to human factors, namely drowsiness and lack of anticipation from the driver when driving his vehicle.

Accident Characteristics at KM 631 A

Accident characteristics at KM 631 A are shown in the following table and diagram:

Table 5
Analysis of Accident Characteristics at KM 631 A

Accident Location (KM)	Time	Vehicles Involved	Accident Type
631 + 000 A	07.03 Thursday, 10/9/2020	Double	Front, Rear
631 + 100 A	05.07 Thursday, 3/12/2020	Doubles	Front, Back

Source: Analysis Result, 2024

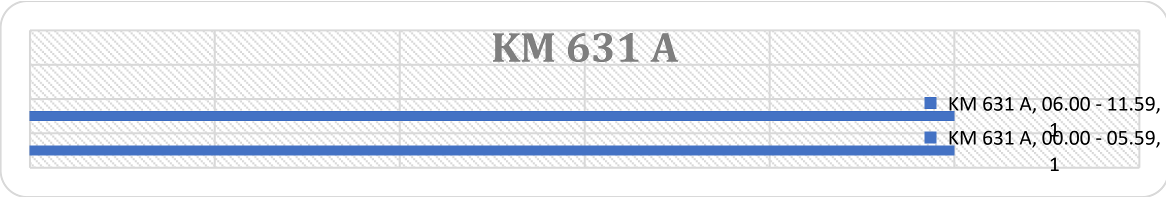

Figure 4. Analysis of Accident Occurrence Time at KM 631 A

In 2020 - 2023 there were 2 (two) accidents at KM 631 A. The vehicles involved were multiple accidents. Accidents occur in the time range of 00.00 - 05.59 and 06.00 - 11.59, namely the range of early morning to noon.

Table 6
Analysis of Accident Characteristics at KM 631 A

Location	Drowsiness	Lack of Anticipation	Tire Rupture
KM 631 A	2		

Source: Analysis Results, 2024

In 2020 - 2023 there were 2 (two) accidents at KM 631 A. The vehicles involved were multiple accidents, where drowsiness while driving the vehicle was the biggest factor causing accidents on the Ngawi - Kertosono toll road section A (Surabaya direction).

Accident Characteristics at KM 619 A

Accident characteristics at KM 619 A are shown in the following table and diagram:

Table 7
Analysis of Accident Characteristics at KM 619A

Accident Location (KM)	**Time**	**Vehicle involved**	**Accident Type**
619 + 450 A	05.59 Saturday, 11/1/2020	Single	Derailed
619 + 600 A	12.52 Friday, 5/11/2021	Double	Front, Rear Collision

Source: Analysis Result, 2024

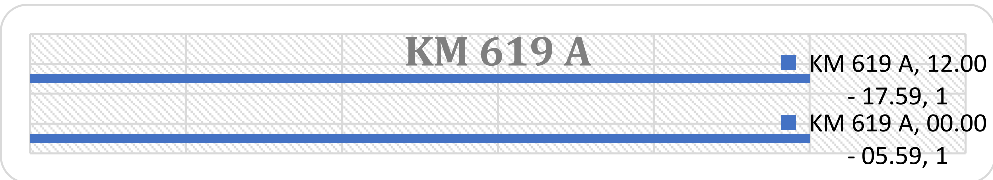

Figure 5. Analysis of Accident Occurrence Time at KM 619 A

In 2020 - 2023 there were 2 (two) accidents at KM 619 A. The vehicles involved were double and single accidents. Accidents occur in the time range categories 12.00 - 17.59 and 00.00 - 05.59, starting from noon to morning.

Table 8.
Analysis of Accident Characteristics at KM 619 A (Driver and Vehicle Factors)

Location	Drowsiness	Lack of Anticipation	Tire Rupture
KM 619 A	1	-	1

Source: Analysis Results, 2024

KM 619 A in 2020 - 2023, accidents occur due to human factors and vehicle factors that cause accidents.

Accident Characteristics at KM 633B
Accident characteristics at KM 633 B are shown in the following table and diagram:

Table 9.
Analysis of Accident Characteristics at KM 633 B

Accident Location (KM)	Time	Vehicle involved	Accident Type
633 + 500 B	01.42 Wednesday, 12/2/2020	Double	Front, Rear Collision
633 + 200 B	At 05.05 Thursday, 18/2/2021	Multiple	Front, Rear Collision
633 + 200 B	21.54 Thursday, 19/8/2021	Single	Derailed
633 + 300 B	18.27 Monday, 11/15/2021	Single	Derailed
633 + 300 B	At 04.35 Wednesday, 11/5/2022	Double	Front, Rear Collision
633 + 700 B	00.35 Monday, 6/3/2023	Double	Front, Rear Collision

Source: Analysis Result, 2024

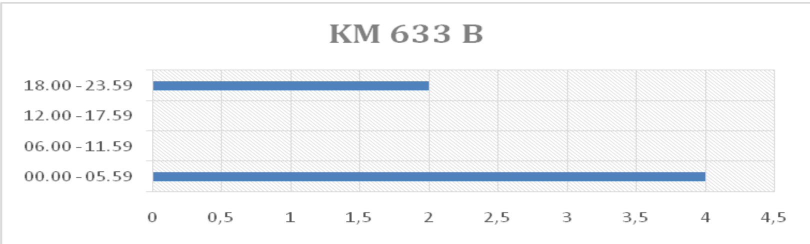

Figure 6. Analysis of Accident Occurrence Time at KM 633 B

In 2020 - 2023 there were 6 (six) accidents at KM 633 B (Jakarta direction). At KM 633 B, many accidents occur in the time range category 00.00 - 05.59 (early morning to early morning).

Table 10
Analysis of Accident Characteristics at KM 633 B (Driver Factor)

Location	Drowsiness	Lack of Anticipation	Tire Rupture
KM 633 B	4	1	1

Source: Analysis Results, 2024

Accidents that occurred at KM 633 B in 2020 - 2023 occurred due to human factors and vehicle factors as the cause of the accident. Drowsiness and lack of anticipation in driving a vehicle are the biggest factors in the occurrence of accidents, besides that there are vehicle factors as a cause of accidents at KM 633 B, namely in the form of tire bursts.

Accident Characteristics at KM 637 B
The results of the analysis of accident characteristics at KM 637 B are shown in the following table and diagram:

Table 11
Analysis of Accident Characteristics at KM 637 B

Accident Location (KM)	Time	Vehicle Involved	Accident Type
637 + 050 B	13.15 Sunday, 5/9/2021	Single	Derailed
637 + 000 B	At 03.15 Saturday, 12/3/2022	Double	Front, Rear Collision
637 + 200 B	18.58 Wednesday, 6/14/2023	Double	Front, Rear Collision
637 + 900 B	23.55 Tuesday, 10/17/2023	Double	Front, Rear Collision

Source: Analysis Result, 2024

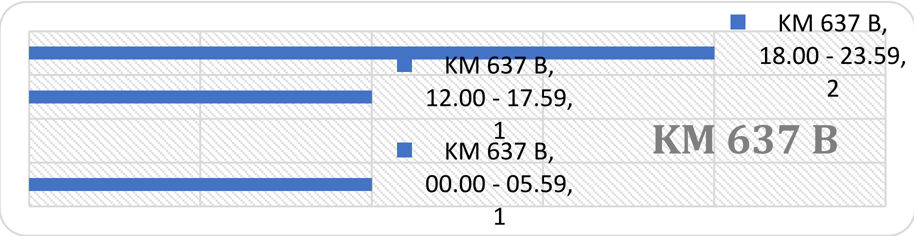

Figure 7. Analysis of Accident Occurrence Time at KM 637 B

In 2020 - 2023 there have been 3 (three) accidents at KM 637 B. Where accidents that occur are accidents involving 2 (two) vehicles / double accidents and also single accidents. Accidents on the Ngawi - Kertosono KM 637 B toll road mostly occur between 18.00 and 23.59 (night).

Table 12
Analysis of Accident Characteristics at KM 637 B(Driver Factor)

Location	Drowsiness	Lack of Anticipation
KM 637 B	4	-

Source: Analysis Results, 2024

Accidents that occurred at KM 637 B in the span of 2020 - 2023 were caused by human factors, where drowsiness was the biggest cause of accidents on the Ngawi - Kertosono KM 637 toll road, causing single accidents or multiple accidents involving 2 (two) vehicles.

Accident Characteristics at KM 639 B

The results of the analysis of accident characteristics at KM 639 B are shown in the following table and diagram:

Table 13.
Analysis of Accident Characteristics at KM 639 B

Accident Location (KM)	Time	Vehicle Involved	Type Accident
639 + 300 B	05.04 Thursday, 31/12/2020	Double	Front, Rear Collision
639 + 100 B	22.05 Wednesday, 22/4/2020	Double	Front, Rear Collision
639 + 300 B	At 01.15 Monday, 13/4/2020	Double	Front, Rear Collision
639 + 600 B	22.35 Wednesday, 31/3/2021	Double	Front, Rear Collision
639 + 200 B	00.20 Sunday, 6/11/2022	Double	Front, Rear Collision

Source: Analysis Result, 2024

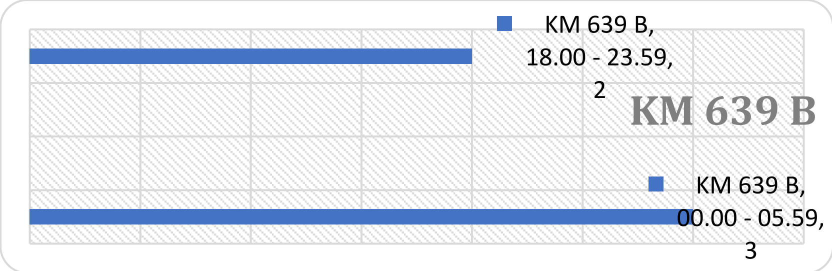

Figure 8. Analysis of Accident Occurrence Time at KM 639 B

In 2020 - 2023 there were 5 (five) accidents on the Ngawi - Kertosono KM 639 B toll road, where the accident involved more than 1 (one) vehicle / multiple accidents and was in the 00.00 - 05.59 (early morning) time range.

Table 14.
Analysis of Accident Characteristics at KM 630 A (Driver Factor)

Location	Drowsiness	Lack of Anticipation
KM 639 B	4	1

Source: Analysis Results, 2024

At KM 639 B of the Ngawi - Kertosono toll road in 2020 - 2023, accidents occurred due to human factors, namely drowsiness and lack of anticipation from drivers when driving their vehicles.

Vision Zero Approach to Handling Toll Road Accident Prone Areas

Based on Government Regulation No. 15 of 2005 concerning Toll Roads, regulates the management of toll roads in general, and is part of the responsibility of toll road operators in this case PT. JNK with support from the central government (KemenPUPR, Kemenhub, POLRI, Kemenkes, KemenBUMN) to support *Vision Zero*, especially on toll road sections in Indonesia, accident insurance company PT. Jasa Raharja, manufacturers of vehicles that can operate on toll roads (Gaikindo, etc.), manufacturers of road equipment traffic infrastructure providers, vehicle body companies, both car bodies for people vehicles and/or general/special goods vehicles and local governments both Provincial Governments and/or District / City Governments around toll roads.

Trans Java Toll Road Pre-Operation Stage

The policy of the Government of the Republic of Indonesia through(Karnachev et al., 2021; Makmur, 2015; National Police Chief Regulation No. 9 of 2012 concerning driving licenses, 2012; Minister of Public Works and Public Housing Regulation No. 10 of 2021 concerning Guidelines for Construction Safety Management Systems, 2021; Minister of Public Works Regulation No. 16/Prt/m/2014 of 2014 concerning Minimum Service Standards for Toll Roads, 2014; Minister of Transportation Regulation No. 134 of 2015 concerning the Implementation of Freight Transport by Motorized Vehicles on Roads, 2015; Government Regulation of the Republic of Indonesia No. 55 of 2015 concerning the Implementation of Freight Transport by Motorized Vehicles on Roads, 2015; Government Regulation of the Republic of Indonesia No. 55 of 2012 on Vehicles, 2012; Presidential Regulation of the Republic of Indonesia No. 100 of 2014 on the Acceleration of Toll Road Development in Sumatra, 2014; Tefianti et all, 2018).

Allows the acceleration of the construction of the Trans Java toll road by prioritizing the construction of sections that are considered strategic to connect important economic areas in Java, where the Ngawi - Kertosono toll road section is part of the Trans Java toll road network. The Trans Java toll road development project is one of the National Strategic Projects (PSN), which means that the licensing, land acquisition, and funding processes are carried out quickly and prioritized by the government, of course this is under the Trans Java toll road development master plan as the main infrastructure network connecting major cities in Java from the western tip (Merak) to the eastern tip (Banyuwangi).

The Ngawi - Kertosono toll road section first carried out a toll road feasibility test, this test is a process carried out to ensure that a toll road section meets safety, feasibility, and functionality standards before it can be fully operated. The toll road function feasibility test is under PUPR Ministerial Regulation No. 10 of 2021 concerning Construction Management System Guidelines which explains that new toll roads must undergo a function feasibility test before being operated, to ensure that the toll road meets the minimum service standards of toll roads following the Minister of Public Works and Public Housing (PUPR) Regulation No. 16 / PRT / M / 2014 concerning Minimum Service Standards (SPM) Toll Roads.

Vehicles operating on toll roads are vehicles that have met technical and roadworthy requirements, following Government Regulation No. 55 of 2012 concerning Vehicles. This is no exception for goods transport vehicles that want to operate on toll roads, must meet technical and roadworthy requirements, comply with dimension and load limits set for the safety of other road users and procedures for transporting cargo under Minister of Transportation Regulation No. 134 of 2015 concerning the Implementation of Goods Transport by Motorized Vehicles on the Road. The vehicle is required to carry out periodic testing activities of motor vehicles at the test site regulated in Minister of Transportation Regulation No. 33 of 2018 concerning Motor Vehicle Types as amended in Minister of Transportation Regulation No. 23 of 2021 concerning the second amendment to Minister of Transportation Regulation No. 33 of 2018, where the monitoring of periodic vehicle tests is under the guidance of the Ministry of Transportation, in this case, the Directorate General of Land Transportation.

Vehicle drivers, driving vehicles on toll roads must have sufficient technical ability and understanding in operating their vehicles safely and securely. The legal aspects of driving licenses are stipulated in Law No. 22 of 2009 on Road Traffic and Transportation, especially in articles 77 to 90 which regulate driving licenses and are supported by National Police Regulation No. 9 of 2012 on Driving Licenses, which outlines the types of driving licenses, issuance requirements, examination procedures, and the validity period of driving licenses. In particular, drivers of goods transportation, whether public goods transportation and/or special goods transportation, must have higher competencies than other drivers. These competencies include large vehicle driving competence (braking system, vehicle maneuvering, vehicle technology devices, etc.), knowledge of cargo (dangerous goods, solid goods, bulk/liquid goods, etc.), physical and/or psychological condition of the driver (driver's working hours, driver's visibility, fatigue level, stress level, etc.).

Past Operation Stage of Ngawi - Kertosono Toll Road

Handling of Accident Prone Areas on Lane A (Surabaya Direction)

Handling recommendations that can be given at KM 630A are as follows: installation of *massive* caution signs, application of *trivia* signs to make drivers always focus on driving their vehicles, and installation of road spikes/delineators to warn drivers when their vehicles pass through the wrong lane / when sleepy.

Handling recommendations that can be given at KM 631A are as follows: installation of road spikes/delineators to warn drivers when their vehicles pass through the wrong lane / when sleepy, installation of *massive* caution signs, application of *trivia* signs to make drivers always focus on driving their vehicles and patrols of toll road officers/police officers at night on accident-prone toll road sections. Handling recommendations that can be given at KM 619A are as follows: application of *trivia signs* to make drivers always focus on driving their vehicles, installation of road spikes/delineators to warn drivers when their vehicles pass through the wrong lane / when sleepy, and the application of *parking bays* for temporary safe resting places for sleepy drivers.

Handling of Accident Prone Areas on Lane B (Jakarta Direction)
Handling recommendations that can be given at KM 633B are as follows: installation of road spikes/delineators to warn drivers when their vehicles pass through the wrong lane / when sleepy, installation of *massive* caution signs, application of *trivia* signs to make drivers always focus on driving their vehicles. Handling recommendations that can be given at KM 637B are as follows: application of *trivia* signs to make drivers always focus on driving their vehicles, a *massive* installation of caution signs, installation of road spikes/delineators to warn drivers when their vehicles pass through the wrong lane / when sleepy, as well as patrols of toll road officers/police officers at night on accident-prone toll roads. Handling recommendations that can be given at KM 639B are as follows: application of *trivia signs* to make drivers always focus on driving their vehicles, installation of road spikes/delineators to warn drivers when their vehicles pass through the wrong lane / when sleepy, *massive* installation of caution signs, as well as patrols of toll road officers/police officers at night on accident-prone toll road sections.

Post-accident Stage on the Ngawi - Kertosono Toll Road Section

a) Rapid accident information system to the Ngawi - Kertosono toll road manager to ensure accidents can be handled quickly by *stakeholders* (police, hospitals, official toll road cranes, etc.)
b) Ensuring *rescue* vehicles such as *ambulances*, cranes, etc., and their equipment (equipment and/or medical personnel) are on *standby* 24 hours a day at points closest to accident-prone areas and the nearest toll booths.
c) Availability of emergency response services at the nearest hospital along with its equipment (medical personnel, equipment, etc.) and can be reached quickly from accident-prone locations on the Ngawi - Kertosono toll road.
d) Ensuring safety and regulating traffic flow by police officers and toll road officers after a traffic accident on the toll road section so that there are no further/successive accidents.
e) Investigation of accidents on toll road sections by toll road managers and related *stakeholders*, to find the causes and further anticipation so that accidents do not occur on toll road sections.
f) Coordinating with post-accident insurance, both PT Jasa Raharja and/or other insurance needed by victims of accidents on toll roads.
g) *Trauma healing* for victims of traffic accidents carried out by relevant *stakeholders* (insurance, toll road managers, Health Office, Police, etc.).
h) Counseling and education for drivers and/or the public regarding the potential dangers of accidents on toll roads on an ongoing basis by *stakeholders* (toll road managers, insurance, transportation agencies, education offices, police, etc.)

i) Review of the legality aspect which is the basis for toll road operational policies, given the development of traffic flow, vehicle types and technology, and the growth of freight movements crossing toll roads, which includes updating policies related to safe toll roads, safe vehicles, civilized and safe drivers and other matters. Given the increasingly *massive* toll road infrastructure in Indonesia.

Determination of *Vision Zero* Policy in Parliament/DPR and Government Domain

a) The need to revise the traffic law in Indonesia, where the spirit of the revision of the law is to reduce the death toll and fatality rate in traffic accidents on toll roads. The revision of the traffic law should be supported by appropriate and comprehensive regulations.

b) The handling of accidents in Indonesia is multisectoral / involves many agencies, it is necessary to make a comprehensive policy, which regulates the handling of traffic accidents that are integrated and involve multisectoral in 1 (one) policy/regulation.

c) Measuring the success of the implementation of these policies by looking at the data in the field (the incidence of accidents and their fatality rates), if the data in the field shows a decrease in the number of casualties and fatality rates then the policy is successful and can be maintained, but otherwise if there is no change then adjustments to these policies are needed.

By implementing this step, it is expected that the number of accidents can be reduced and the goal of *Vision Zero*, is to eliminate the number of deaths / zero deaths and serious injuries on the highway, especially on the Ngawi-Kertosono Toll Road. This holistic approach involving infrastructure improvements, education, and law enforcement will greatly contribute to improving traffic safety in Indonesia. The *vision zero* road safety approach on the Trans Java toll road is fundamentally laid out in the figure below.

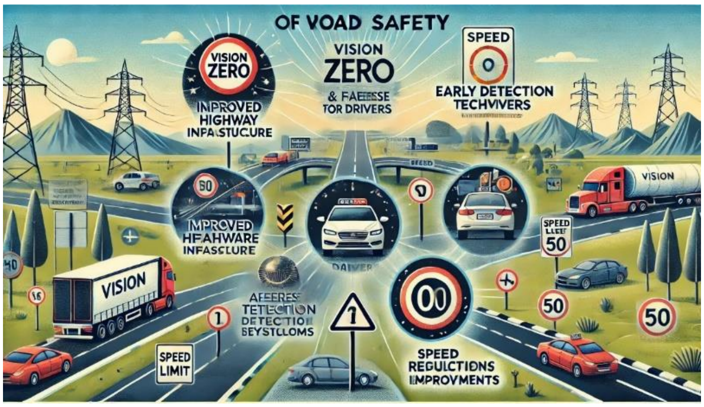

Figure 9. Toll Road Safety Handling (*Vision Zero*)

Based on this accident pattern, the implementation of the *Vision Zero* principle is very important. Improving safety infrastructure, such as improving toll road conditions and adding road infrastructure, will help reduce chain-reaction crashes. In addition, awareness campaigns for drivers need to be conducted to educate them on the dangers of drowsiness and the importance of anticipation when driving. The implementation of early detection technologies, such as cameras and fatigue detection systems, can also help identify drowsy drivers in vulnerable locations. Lastly, improving speed regulations in potentially dangerous zones will go a long way to improving safety on this toll road. With these measures, it is hoped that the number of accidents can be significantly reduced, in line with *Vision* Zero's goal to achieve zero road accidents.

CONCLUSION

The crash data analysis has identified several vulnerable areas that need special attention. The *vision zero* approach can be an effective strategy to reduce fatal accidents with a focus on highway fatalities. Therefore, important steps that need to be taken include infrastructure improvements, such as installing clearer traffic signs and improving road geometry, as well as driver education through *defensive* driving training programs and awareness campaigns on the risks of driving in dangerous spots. Law enforcement also needs to be strengthened against traffic violators to provide a stronger deterrent effect. In addition, the implementation of an integrated and sophisticated traffic monitoring system involving toll road *stakeholders* can help detect and prevent potential accidents in *real time*. With this implementation, it is expected that the fatality rate of victims can be reduced on the Ngawi-Kertosono Toll Road and approach the goal of *vision zero*.

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